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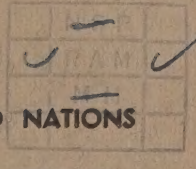
REPORT OF THE

EIGHTH MEETING OF THE WORKING PARTY ON RICE PRODUCTION AND PROTECTION OF THE INTERNATIONAL RICE COMMISSION

Held at Peradeniya, Ceylon
December 1959

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS



Beginning in January 1955, reports of FAO meetings, held as part of the Program of Work of the then Agriculture Division, were issued in the present form and numbered chronologically within each calendar year.

Since the establishment of the Plant Production and Protection Division in January 1959, the serial annual chronological numbers refer to reports issued by this Division.

Earlier reports of the International Rice Commission's Working Party on Rice Breeding have been issued as follows:

Rice Breeding

First Meeting of the Working Party on Rice Breeding, Rangoon, Burma, February 1950
Second Meeting of the Working Party on Rice Breeding, Bogor, Indonesia, April 1951
Third Meeting of the Working Party on Rice Breeding, Bandung, Indonesia, May 1952
Fourth Meeting of the Working Party on Rice Breeding, Bangkok, Thailand, September 1953
Fifth Meeting of the Working Party on Rice Breeding, Tokyo, Japan, October 1954
Sixth Meeting of the Working Party on Rice Breeding, Penang, Malaya, December 1955

Joint Report of the Seventh Meeting of the Working Party on Rice Breeding; the Sixth Meeting of the Working Party on Fertilizers; and the First Meeting of the *ad hoc* Working Group on Soil-Water-Plant Relationships, Vercelli, Italy, September 1957

Meeting Report
No. 1960/PL 5

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of the

International Rice Commission

Held at

Peradeniya, Ceylon

14-19 December, 1959

Food and Agriculture Organization of the United Nations
February 1960 Rome, Italy

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INTRODUCTION

At the 6th session of the International Rice Commission held in Tokyo in 1958, it was decided that a Working Party on Rice Production and Protection should be established to continue and widen the work of the previous Working Party on Rice Breeding. The first meeting of this re-organized Working Party (the eighth in the series of meetings) was convened by the Food and Agriculture Organization of the United Nations and was held by invitation of the Government of Ceylon in Peradeniya from 14 to 19 December 1959. The meeting was attended by 46 participants representing 16 Governments, and 2 observers from 2 organizations.

All sessions were held at the University of Ceylon at Peradeniya. In the opening speech, Sir Nicholas Attygalle, Vice-Chancellor of the University of Ceylon, stressed the importance of increasing the yields of rice in countries like Ceylon where rice is the staple food and where the rapid increase of population demands more and more food every year. Mr. H.W. Cummings, Representative of the Director-General of FAO explained the re-organization of the Working Parties of the International Rice Commission. He also drew attention to the FAO Freedom From Hunger Campaign and the World Seed Campaign and pointed out how well the program of the Working Party may be integrated with the objectives of these campaigns.

PARTICIPATION IN THE MEETING

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Officers of the Meeting

Chairman:	-	M.F. Chandraratna, Ceylon
Vice-Chairman:	-	S. Hedayetullah, Pakistan
Technical Secretaries:	-	G. Julén, FAO, Rome
	-	H. Walker, FAO, Rome
Drafting Committee:	-	Nelson E. Jodon, U.S.A.
	-	L.E. Fernando, Ceylon
	-	Ahmad Yunus, Malaya

Acknowledgments

The Working Party expressed its appreciation of the welcome extended to participants of the meeting by Sir Nicholas Attygalle, Vice-Chancellor of the University of Ceylon, and further for the provision of the excellent accommodation facilities at the campus of the University of Ceylon in Peradeniya. These arrangements and the beautiful surroundings contributed substantially to the atmosphere and the success of the meeting.

The delegate of Pakistan, in his vote of thanks on behalf of the delegates, thanked the Government of Ceylon and in particular its Director of Agriculture, Dr. M.F. Chandraratna, for the excellent arrangements made for the meeting and for the organization of visits to the famous Botanical Gardens at Peradeniya, the Institutes of the Department of Agriculture, and visits to the hill region and the dry zone, as well as for the cordial reception and hospitality extended to the participants.

The meeting expressed its indebtedness to the Chairman and Vice-Chairman for the efficient manner in which they conducted the Sessions. Appreciation was also extended to Dr. L.H. Fernando and his cooperators of the organizing committee, the Documents Officer, the interpreters, the typists and others who had so effectively carried out their duties in connection with the meeting.

SUMMARY OF DISCUSSIONS

International Rice Hybridization Project

The results obtained from the indica-japonica hybridization project as well as the results from the parallel project carried out in India were reported.

In the IRC project a total of 96 indica varieties were crossed with 10 japonica varieties giving 490 cross combinations. All crosses were done at the Central Rice Research Institute at Cuttack, India, where the F_1 generation was also grown. F_2 material was distributed to various countries for selection. In the Indian project 97 indica varieties were crossed with japonicas giving 320 combinations.

The F_1 plants were very vigorous and exhibited considerable heterosis with regard to plant height and number of ears per plant. They showed, however, a high degree of sterility, this being 60-70% in most hybrids. There were no significant differences in sterility in the hybrids from the different japonica parents, but the hybrids from a few indica varieties consistently showed a comparatively low sterility. Generally, homozygous lines were obtained in F_6 for such characters as flowering time, height, grain size, habit, etc., but in some cases considerable heterozygosity was found even in F_7 and F_8 generations.

With regard to the results from the different countries, the following points may be mentioned:-

Burma: At Mandalay in North Burma, 22 F_7 lines were selected, a few of which appear to be promising. Plant selections are being made on the basis of row yields. At Hmawbi in South Burma, 86 F_6 lines were tested, a few of which were found to be equal to the standard varieties with regard to yield, and superior with regard to grain quality.

Indonesia: Eighty-one lines from 7 cross combinations were tested in preliminary yield trials in 1957-58. Only 3 lines were found suitable for final yield tests. One of these lines was equal to Ramadja with regard to yield but all of them were inferior to Djelita.

Malaya: Lines in the advance generations averaged a high degree of homozygosity. Plant yields have progressively increased over the preceding generations in 1958-59, most plants selected giving yields of over 100 grams per plant as compared to 50-70 gram yields of the indica parents. Selections for low sensitivity to photoperiodism for double cropping have been in progress since 1958 and the work of synthesizing high yielding short-strawed varieties was expanded in 1958. Strains suitable for double cropping are now being tested both in the main and second seasons.

Pakistan: Selections have been made for erect habit, fertility, height, tillering and yielding capacity. In the early generations individual selected plants gave two to three times the yields of indica parents, but in later generations this superiority was not maintained.

Philippines: At Maligaya under lowland conditions 36 lines were tested in preliminary yield tests. Four lines were selected and tested at 5 places in 1958, one of them being comparable to the checks. At Los Baños under upland conditions 21 F_5 lines were tested of which 4 were selected for further tests. One of them was equal to the check varieties.

Thailand: The selected progenies are now in different stages of selection from F_5 to F_9. So far no yield data have been recorded. Selections are made on grain size and quality requirements of the country.

Viet Nam: A total number of 136 lines from F_5 to F_8 generations are under study, and a few of them are giving promising results.

North Australia: Seven uniform lines have been selected from the first material obtained in 1955. These were found to be suitable for the winter season when japonicas are grown. Two selected lines were found to give good response to high level fertility. From material obtained in recent years, selections are still in progress for suitability for growing in the summer season. There is need for short-strawed, non-lodging indica grain types which respond to high fertilizer applications and there are indications that this objective might be partially achieved.

India: The material has been grown under normal and high levels of fertility. Selections of single plants have been continued up to F_6 and F_7. The results indicate that some of the lines were more responsive at normal fertilizer level than the respective indica parents. Under a higher fertility they were found either equal to the indica parent or, in some cases, inferior. Out of 45 lines, 9 have given significantly higher yields over the respective indica parents, the increase ranging from 29% to 100% under normal fertility conditions.

From the results so far obtained the following conclusions can be drawn:-

(i) The F_1 generation shows a high degree of heterosis in the expression of characters, such as height and tillering.

(ii) F_1 sterility did not prove to be disadvantageous, as selections could be made for increased fertility in the course of the succeeding generations and fully fertile homozygous lines were later obtained.

(iii) In no country was selection in F_2 made under a high level of fertility.

(iv) With the exception of India, no country has conducted experiments to find the response of final selections to different levels of fertility as compared with the respective indica parents.

(v) The final promising cultures are from crosses involving the following japonica parents:

Australia: (winter selections) - Norin 6, 8, 18, Rikuu 132

Burma: Norin 6, 8, 18, Rikuu 132, Asahi

India:
Andhra: Norin 18,20,36, Rikuu 132
Cuttaok: Norin 6,17,18, Rikuu 132, Asahi, Taihoku
Orissa: Norin 20, Rikuu 132, Asahi

Philippines: Norin 1, 6

Thailand: Rikuu 132

(vi) It is found that Rikuu 132, which has been giving good results as a parent in 6 of the 7 places mentioned above, has a high degree of general adaptability.

(vii) The following good qualities have been introduced into the selections: non-shattering, high tillering, non-lodging habits, good quality grain, early maturity, low sensitivity to photoperiodism, and higher response to fertilizers under a medium level of fertility.

On the basis of experience gained in this project it was recommended that in the future the material now available from the indica-japonica hybrid projects should be tested at least under two, or preferably three levels of fertility, the highest being at least 80 kg. nitrogen per hectare with sufficient amounts of phosphorous and potassium, and that one of the check varieties should be the indica variety used as the parent in the cross. It was also recommended that countries should produce new hybrids using as the indica parent the best varieties with respect to characters such as high yielding capacity, stiff straw, wide adaptability, high fertilizer response, disease resistance, etc., and as the japonica parent varieties which show low sensitivity to photoperiod and wide adaptation, such as Rikuu 132, Taichung 65, Norin 1, Norin 17, and Fujisaka 5. Selection for yield should not be made before the fifth or sixth generation. Selection for other characters governed by major genes should be done in the early generations. Each generation should be grown under a high fertility level from F_2 onwards and selection for yield should be done under medium and high levels of fertility. Emphasis should be placed on resistance to diseases and pests in the course of selection.

The Working Party noted the promising practical results obtained in some countries and the valuable experience in the increased knowledge gained in the project and realised that better results could be obtained in a shorter time if the best parent varieties were used and hybrid material was treated as mentioned above.

The Working Party therefore recommended -

that in all countries, further selections in hybrid material now available should be done on a high fertility level;

that in all countries new hybrids be produced between the most suitable indica and japonica varieties, all generations being grown under a high fertility level and selections made in accordance with the recommendations given above;

that FAO be requested to collect information on the most suitable japonica parent varieties and to assist in obtaining seed of these varieties.

Linkage Studies and Nomenclature of Rice

In order to encourage genetic studies on rice the Working Party on Rice Breeding nominated at its sixth meeting held in Malaya in 1955 a Committee consisting of Mr. N.E. Jodon of the USA, Dr. S. Nagao of Japan and Dr. N. Parthasarathy of India to examine the present position of linkage studies in rice and resolve difficulties of genic nomenclature. A report of this Committee was presented to the meeting.

Two sets of symbols for the same or similar genes in rice have been developed - one by rice geneticists in Japan and another by Indian and American geneticists. The report of the International Committee on Genetic Symbols and Nomenclature was adopted by the Tenth International Genetics Congress held in Canada in August 1958. In this report rules for gene symbols are laid down to provide a guide to eventual uniformity of usage by all rice geneticists. Following these rules the Working Party Committee prepared a list of 92 gene symbols for qualitative characters reported in the literature on rice genetics. Symbols were omitted in cases where the manner of inheritance is in doubt, as well as in cases of quantitative characters. For many characters entirely new symbols had to be selected.

As a basis for determining characters for which standard gene symbols should be established, the Committee tabulated results of rice genetic studies published since about 1940. These tabulations together with the accompanying bibliographies constitute a useful concise summary and check list of genetic work in rice. The intention is to publish them in the near future as a review paper.

In publications on rice genetics it is necessary to refer to the various plant parts in which gene expression takes place. There is, however, some lack of uniformity in terminology and in the interest of greater accuracy in writing and better understanding in reading genetic papers, it was suggested that a complete set of morphological and histological diagrams properly labelled in English should be prepared and published.

The Committee in their report summarized linkage studies in rice so far undertaken. Twelve groups have been indicated corresponding to the twelve haploid chromosomes. Maps of these groups were presented to the meeting which it was proposed should be published together with tabulations of characters mentioned above.

The Working Party stressed the desirability of using a uniform set of genetic symbols and adopted the list of proposed recommended symbols with a few minor revisions.

The Working Party recommended -

that the list of recommended symbols be published in the IRC Newsletter;

that these symbols be used by all rice geneticists in their future publications, and that during the period of transition to the use of the recommended symbols the rice geneticists also include in their publications the symbols previously used for characters on which they are reporting;

that in the future new gene symbols in conformity with the rules adopted by the Tenth International Genetics Congress be set up by the workers as the need arises;

that the tabulation of characters and the maps of linkage groups prepared by the Committee be published as soon as possible;

that FAO envisage the possibility of publishing a complete set of morphological and histological diagrams on rice, properly labelled in English.

Observations on "Intermediate" Rice Varieties Distributed in 1958

In accordance with a recommendation of the previous meeting of the Working Party, FAO collected seed of 71 "intermediate" rice varieties from Cuba, Indonesia, Italy, Malaya, Taiwan and the U.S.A. Seed of these varieties was distributed to Burma, Ceylon, India, Indonesia, Italy, Japan, Malaya, Pakistan, Spain, Thailand and the U.S.A.

Observations have been made on the various characters and great variation has been found with regard to earliness, height and tillering capacity, and only a few of these varieties have been found equal to the local ones as regards yield. As, however, the objective was to use these "intermediates" instead of japonica varieties in crosses with indica varieties in order to introduce high fertilizer response, it will be necessary to test them for fertilizer response before any conclusion can be drawn regarding their usefulness in this respect.

Cooperative Variety Trials

From among the countries of the warm temperate region reports were received on the trials from Egypt, Japan, Korea, and the U.S.A., and of the tropical region from Burma, India, Indonesia, Malaya, Madagascar, East Pakistan and Viet Nam. In most cases japonica varieties with a few "intermediates" and indicas from the U.S.A. were included in the trials in the sub-temperate countries, while in the tropical region the trials included indica varieties selected from the list of the different groups prepared in 1956 for the conducting of these trials.

From the data obtained from the warm temperate region it was noted that the japonica varieties from Japan and Korea, with the exception of Sasasigure and Tsurugiba from Japan, gave more than three tons per hectare at Beaumont (USA). Of the Japanese varieties, Norin 29 and Sasasigure were outstanding at Iri Agricultural Station, Korea, and Norin 29, Norin 6 and Tsurugiba in Egypt. Norin 29 has done uniformly well at the agricultural stations of the warmer regions of Korea and seed of this variety is now being multiplied on a large scale for distribution to the farmers of this country . Of the American varieties, Caloro gave a good performance in Korea. Pebifun, a Taiwan variety, has given the top yield of 4.78 tons per hectare at Stuttgart (USA), even though the growing conditions during the year of trial were not so favourable as at Beaumont.

From the results of extensive trials conducted at six locations during 1957-58 and 1958-59 in Java, it was found that Mtu 19, a variety from Andhra State, India, gave consistently good yields. Due to its low grain weight, however, it may not be popular with the Indonesian farmers. It is, nevertheless, of value as breeding material in view of its adaptability to Indonesian conditions. The same variety gave the highest yield in one set of trials in Hmawbi Research Station, South Burma. Trials conducted at Mandalay, North Burma, indicated that the Indian varieties, Co 14 in one set of trials, and BAM 9 in another set, were found to be superior to the respective local standards. In one set of trials conducted in Malaya, BAM 9 was superior to Radin Kling. Other varieties which were found to be of promise in Malaya were Peta from Indonesia, T.4450 from India and Engatek from Borneo. From the results of 3 years trials conducted in Vietnam, it was found that Co 19 from India, Rayong 6, Quezon and Seaupketchil from the Philippines were superior to the respective local checks. None of the varieties tested in East Pakistan was found superior to the leading local varieties, Nigersail and Latisail. In trials conducted in Madagascar over a period of three years, some foreign varieties, especially Bhasumanik, Patna 23, T 141 from India and Dudshar from Pakistan, have been superior to the local standard varieties.

The following varieties from India have shown adaptability to conditions at different latitudes and given good results in the countries indicated below:-

1.	Mtu 19	(from Andhra)	in Burma and Indonesia
2.	BAM 9	(" Orissa)	" Burma and Malaya
3.	Co 14	(" Madras)	" North and South Burma
4.	AdT 8	(" ")	" Malaya

Reports were received from only 6 out of the 11 participating States of India. From the trials conducted over a period of 3 years, the following varieties appear promising in the different States:-

Andhra	Milfor (Philippines), Murunga-307 (Ceylon), and A.29-20 (Burma)
Kashmir	H. Sinchu (Japan)
Kerala	Ramdeja (Indonesia)
Madras	Bengawan, Intan, Tjahaja (Indonesia)
Orissa	A 28-8 (Burma)
W. Bengal	B 43-11, A 28-8, B 24-92, D 25-4, D 17-18 (Burma), Apostol (Philippines).

The continuance of these trials on a cooperative basis, and the value of this project in its present form was discussed. It was felt that it would be better if a modified program were worked out with the objective of testing such varieties which have already shown wide adaptability in their own countries for adaptability in other countries. It was suggested that for this purpose each country should send to FAO a list of varieties which have given good results under various conditions and in different parts of the country, giving a complete description of the characters of the varieties. These lists should be compiled and circulated to all member countries. Each country should select from this list those varieties which appear to be suitable for testing. The results on all tested varieties should be compiled by FAO and sent to all member countries. New outstanding varieties should be added to the list

as they become available from the countries of origin. The possibility of having certain varieties included in the trials in all countries or groups of countries was discussed, but it was felt that it would be better if the breeders in each country were free to select those varieties which they thought to be most suitable for their purpose.

The Working Party realizing the importance of an intensified exchange of promising improved varieties and of information on their performance in various parts of the region, recommended -

> that the cooperative variety trials in the present form be discontinued and be replaced by a project aiming at testing promising varieties, which have shown wide adaptability in their country of origin for their suitability in other parts of the region;
>
> that FAO be requested to formulate a detailed plan for this project and that the Regional Rice Improvement Specialist should act as coordinator.

Variety-Fertilizer Interaction

Since 1951 when the Working Parties on Rice Breeding and on Fertilizers jointly approved the coordinated "Investigation of Variety-Manuring Interactions with particular Reference to N and P", member countries of IRC have conducted an active search for *indica* varieties that manifest marked fertilizer response. Results of investigations from Australia, Ceylon, Egypt, French West Africa and Madagascar, India, Indonesia, Iran, Pakistan, the Philippines, and the U.S.A. were reported to the meeting. Of the various nutrient elements, only nitrogen has been extensively investigated. In all reporting countries, except Pakistan and the Philippines, significant variety-nitrogen interaction has been reported, some varieties showing good response. The results from Pakistan and the Philippines indicate a negative effect on yield of nitrogen when given alone.

The performance of the *japonica* x *indica* hybrids reported from Australia is of particular interest. Two selections, G 15-16 and G 16-56 manifest the virtues of high fertilizer response, high ratio of grain to straw, and lodging resistance. These were the objectives of the *japonica* x *indica* project.

There are now definite indications in Ceylon and India that the *japonicas* give high fertilizer response under tropical conditions. It has been stated that Norin 1 and Kanan 8 behave in Ceylon in the same way as they do in Japan. From several member countries it was reported that considerable gene reserves of fertilizer response have been found in the indigenous *indica* varieties. According to results obtained in Ceylon there is however greater possibility of obtaining good fertilizer response if selection is made after crossing different *indica* varieties, than in direct selection. For instance, the variety H4 obtained from such a cross shows a nitrogen response equal to that of the best *japonica* varieties.

The desirability was stressed of establishing response curves for all varieties under test to make possible a detailed comparison of the behaviour of these varieties. A sufficient number of fertilizer levels to permit the calculation of a quadratic regression function of the type $y = a + bx - cx^2$ should therefore be included in all experiments. It was also pointed out that if nitrogen response is to be studied accurately, all other limiting factors must be removed so far as possible. Sufficient amounts of other nutrient elements must therefore be supplied and the best cultural practices should be used in the trials. As large doses of nitrogen will increase the susceptibility to lodging and to blast, it is necessary to determine whether, in case of low yield at high fertility level, this low yield is due to low fertilizer response or to damage by lodging or disease.

To obtain the most efficient use of nitrogen it is necessary to apply the fertilizers in accordance with the need of the plants at different stages of development. As the uptake and utilization of nitrogen during the stages of development varies in different types of rice, it was suggested that a more thorough study should be made with regard to the time of application of nitrogen, not only for rice in general but also for the different types of rice.

The Working Party realizing the great possibilities of increasing rice production by the use of more fertilizers, recommended -

that the investigations on variety-fertilizer interaction be continued and requested Dr. Chandraratna of Ceylon to continue to act as coordinator;

that in conducting these experiments a sufficient number of fertility levels should be included to make calculations of response curves possible;

that as far as possible all other limiting factors be eliminated by using the best cultural practices in these experiments;

that in the future emphasis be given to breeding for high fertilizer response together with resistance to lodging and disease;

that testing for yield should be done at at least two levels of fertility (normal and high);

that the countries which maintain the world genetic stock of indicas be requested to grow these stocks at a high level of fertility and records be taken of the straw:grain ratio as well as the panicle number and panicle weight.

Physiological Diseases

Information on physiological diseases was collected by Dr. Takahashi, the project coordinator, from the following countries:-

Burma, Cambodia, Ceylon, China, Indonesia, Japan, Korea, Laos, Malaya, Pakistan, Philippines, Thailand, U.S.A. and Viet Nam.

Reported diseases were classified according to various aspects, such as soil conditions, fertilizer relations and time of appearance of the disease.

It seems that the only dominant group of physiological diseases appears at the tillering stage of paddy in areas of high water table. To this group belong the following:-

Amyit-po (Burma), Bronzing (Ceylon), Chin-sng Tsan (China), Mentek (Indonesia), Akagare (Japan), Stifle (Korea), Penyakit Merah (Malaya), Pansuk (Pakistan and India).

In Thailand the same type of disease also occurs, although not yet named. The cause of this type of disease is attributed to various factors. In Ceylon and China it is attributed to iron toxicity. In Japan, ferrous iron, toxic organic acids and lack of oxygen at the roots are suspected to be the cause of the physiological disturbance. In Indonesia, reduced conditions in the soil together with low availability of phosphorus and potash are presumed to be the cause. It should be explained, however, that the suspected causes are inseparably connected with each other. For instance, one cannot claim iron toxicity without admitting at least the possibility of organic acid toxicity, or vice versa.

Concerning the remedial treatment the consensus of opinion is that the paddy fields should be provided with internal or external drainage. Possibly this would render innocuous all the detrimental substances so far suspected. Any measure that causes the soil to become more oxidative appears to alleviate the symptoms of disease. This naturally leads to the conclusion that good drainage facilities are necessary to resolve the problem. Unfortunately this type of disease is usually found in the very lowest part of a paddy growing area.

Akiochi in Japan is entirely different from the group of diseases discussed above, because it usually occurs on well drained sites and at the reproductive stage of paddy. In some instances at least the vegetative growth of the plants affected with Akiochi may be as good or better than that of the normal plants. The problem of the best remedy for Akiochi would appear to have almost been solved. The disease is overcome by suspending applications of fertilizers containing sulphate and by applying to the soil materials rich in iron, and the adoption of Akiochi resistant varieties.

"Straight Head" in the United States is liable to occur in places of poor drainage and on soils of high organic matter content. The disease can be prevented by draining the fields at the initiation of the reproductive stage of the crop. However, since draining the land is not economic, the United States workers are now concentrating their efforts on breeding resistant varieties.

"Straight Head" also occurs in Japan when a field persistently used for upland crops is turned to paddy for the first time. The disease can be cured by making the soil oxidative at the beginning of the reproductive stage.

Akagare of Japan which has recently caused serious trouble, may be the only exception in that it becomes serious on land with good drainage. This disease occurs on sandy or gravelly soils at the milky stage of development

of the rice plant. Excess of nitrogen and shortage of potash is presumed to be the cause.

In Thailand and Cambodia a physiological disease due to soil acidity occurs widely. The cause is attributed to aluminium toxicity. Unfortunately the disease cannot be entirely cured by the application of lime, because the soil is generally too impoverished.

Myit-po in Burma can be cured by phosphorus, and "Yellowing" in the same country, by the application of sulphate.

In conclusion, it is felt that with few exceptions, the physiological diseases of rice so far studied are more or less related to the development of soil conditions that are too reductive. Critical point of reduction may be somewhere around -100 mV (Eh6) at least so far as Akagare and evolution of hydrogen sulphide is concerned. It is considered that one or more of the following elements and compounds may be responsible for the diseases: ferrous iron, manganous manganese, hydrogen sulphide, butyric acid and formic acid. There are some indications that the main cause for a particular disease may differ according to soil and climatic conditions. However, regardless of the difference in the causes, it would seem that the diseases can be cured, prevented, or at least, alleviated by making the soil oxidative.

A short report was submitted on the work now in progress in Ceylon on the physiology of the bronzing disease. It would appear that bronzing due to excessive iron concentration is only one aspect of the wider problems of root damage and malnutrition of paddy.

Sulphide injury in rice, similar to "Akiochi" disease of rice in Japan, has not been widely reported from India, although instances of its sporadic occurrence have been observed in the south of the country in Kerala and Andhra States. Recently in 1958 characteristic symptoms of sulphide injury occurring were observed in certain locations on soils with impeded drainage at the State Agricultural Farm at Bhubaneswar (Orissa). This occurred on highly leached soil of lateritic origin. Symptoms of injury showed up after about 30-40 days of healthy growth.

The Working Parties recommended that member countries should strengthen their investigations on physiological diseases of rice on a cooperative basis and that Dr. J. Takahashi of Japan be requested to continue to act as coordinator.

Ways and Means of Reducing the Number of Varieties

In many rice growing countries the number of varieties is very high. Many of these varieties can be grown only in restricted areas due to great sensitivity to environmental conditions. Some of them are also low yielding, and in order to increase the average yield these low yielding varieties should be removed and be replaced by the more high yielding ones. In order to make the multiplication and distribution of high quality seed of good varieties efficient, it is necessary that the number of varieties be as low as possible, and that the recommended varieties have enough adaptability to be grown over large areas. When the number of varieties after proper testing and selection has been reduced,

the future breeding work should be directed to the development of varieties with wide adaptability. This program is now recognized by all member countries.

In Ceylon 208 varieties were previously grown. On the basis of field trials and with the development of varieties with higher fertilizer response and wider adaptability, the number of recommended varieties has now been reduced to 14. The delegate from Ceylon indicated that where cultivation standards are low and fertilizer applications are inadequate, a large number of varieties are grown, but with improved methods of cultivation and increased fertilization these can be replaced by a few varieties showing high fertilizer response and wide adaptability.

In Thailand and Indonesia systematic tests at the regional stations as well as extensive tests on farmers' fields at a number of locations have led to a considerable reduction in the number of recommended varieties. In Japan with a high latitude range, it was previously necessary to have a large number of varieties. However, the recent trend in the demand for superior characteristics is leading towards a reduction of the number of varieties. The development and extension of early season planting has restricted the number to a few superior early maturing varieties over a large area. Moreover, certain specific requirements in the varieties such as high fertilizer response, resistance to blast, non-lodging and specific grain quality limit the choice to a few superior varieties. In Viet Nam and Malaya regional tests have already been started in the different rice growing provinces. It was reported that in Taiwan, the number of varieties listed in the seed multiplication and distribution program is only 20. The average number of varieties multiplied in each district is only 5. In this connection, it was pointed out that the recommended varieties for the multiplication and distribution must be based on regional tests.

The importance of short or medium maturing varieties with low sensitivity to photoperiod was stressed and the delegate from Ceylon pointed out that the genes for low sensitivity to photoperiod could be transferred by back crossing and selection.

The fourth FAO Regional Conference for Asia and the Far East held in Tokyo in 1958 suggested that the International Rice Commission through its Working Party on Rice Production and Protection should consider setting up, as its contribution to the World Seed Campaign, a study group to investigate ways and means to reduce the large number of local rice varieties in many countries. After having discussed this suggestion, the Working Party found that the work on the reduction of the number of varieties was well under way in most of the countries in the region, and that very good results had already been obtained in several countries. The Working Party therefore did not consider it necessary to set up such a study group. It did, however, realise the importance of an intensification of the work in many of the countries and recommended -

> that in all countries extensive regional testing of varieties should be conducted as the basis for the evaluation of already existing and of new varieties, the best varieties to be multiplied and distributed to farmers as soon as possible;
>
> that in each country a list of recommended varieties be issued and that these lists be revised from time to time and old varieties be withdrawn from the lists and from the seed production program as soon as better varieties become available;

that in the breeding program greater emphasis be placed on selection for varieties which show the widest possible adaptability;

that fundamental studies on photoperiodism and thermosensitivity of rice varieties should receive greater attention in order to provide the breeders with basic information relating to the adaptability of varieties.

Seed Multiplication, Certification and Distribution

At the previous meeting of the Working Party it was recommended that FAO should take steps to furnish interested countries with an outline of the essential features of several of the most satisfactory seed improvement schemes now in operation. For that purpose representatives from different countries were asked to send to FAO information on their seed production and distribution regulations. Information had been submitted by Australia, Ceylon, France, India, Japan, the Philippines, Portugal, Taiwan, Thailand, the U.S.A. and Venezuela, and a summarization was presented to the meeting.

FAO World Seed Campaign

The Technical Secretary gave a review of the World Seed Campaign and informed the Working Party that the last FAO Conference decided that 1961 should be the World Seed Year, and that after 1961 the Campaign should continue as part of the Freedom from Hunger Campaign. Information was also given on the International Training Centre on Genetics and Plant Breeding offered by Sweden as a contribution to the World Seed Campaign. The Training Centre is to be held in Sweden from March to September 1960 and invitations have been sent to the Near and Middle East countries, including India, Ceylon and Pakistan.

It was noted in the discussion that interest in the use of improved seed is increasing in all countries in the region, that in several countries a well organized seed multiplication scheme is in operation, and that in other countries plans for such programs are being developed.

The Working Party realizing the great importance of increased use of improved seed gave its full support to the FAO World Seed Campaign and recommended -

that in all member countries steps should be taken to strengthen the work on rice seed improvement, special emphasis being given to extensive variety tests, reduction in the number of varieties and production and distribution of seed of improved rice varieties.

Review of Pests and Diseases of Rice in the Field

I. Pests

Delegates reviewed the pest situation in their territories, drawing attention particularly to those species which are considered to be of greatest economic importance.

Australia: In the northern rice area, situated near Darwin, the area of rice cultivation is small and pests are not at present of economic importance. The most potentially serious pests include several species of birds (Anseranas semipalmata, Porphyrio porphyrio, and three species of Kakatoe), and the stem borers, Scirpophaga innotata and Chilotraea. In the southern rice area in New South Wales the important pests are a chironomid bloodworm, an Agromyzid, a caddis fly larva and the rice beetle, Dicranolaius bellulus.

Ceylon: Of first importance is the stem borer Schoenobius incertulas which is found in all rice growing areas of the country. The rice gall midge Pachydiplosis oryzae also causes serious damage and is particularly conspicuous during the seedling stage. The rice bug Leptocorisa varicornis is universally present, very destructive and, although effectively controlled at present with BHC dusts, is potentially serious in view of the appearance of insecticide resistance.

Federation of Malaya: Only the lepidopterous stem borers, of which Chilotraea polychrysa and Schoenobius incertulas are the commonest, are of widespread occurrence and can be regarded as serious pests. Other pests of some importance, but which are sporadic in their appearance, include the sucking bug Leptocorisa acuta and the army worm Spodoptera mauritia. Non-insect pests include birds, crabs, wild hogs and rodents.

France: In France the most dangerous pests are species of Chironomus and Cricotophus. Leaf miners, Hydrellia incana and H. griseola are also of some importance, as is the crab Triops cancriformis. In Tropical Africa, including Madagascar, the most serious Lepidopterous pests are the leaf-eating species Laphygma exempta (West and Equatorial Africa), and L.exigua (West Africa), the stem borer Procoras africana (the Logou Valley), Cirphis loreyi which feeds on leaves and young stems in West Africa, various species of Sesamia in Equatorial Africa and Madagascar, and Enosima victiferella in Madagascar. Coleopterous pests include Trichispa sericea (West Africa and Madagascar) and Hispa gestroi and Heteronychus plebejus (Madagascar). Among the Hemiptera, Leptocorisa apicalis and Nezara viridula occur in West Africa and the leaf hopper Nephotettix apicalis in Madagascar. Diptera of importance are Pachydiplosis oryzae, present in all territories, and Diopsis spp. Non-insect pests include birds, particularly Quelea spp, rats and fish.

With regard to fish being pests, it was reported that the herbivorous species Tilapia melanopleura and Tilapia zillii have been pests of rice during high water time since they were introduced into Madagascar. Normally the rice fields damaged are the flooded ones situated on the very banks of lakes and ponds and probably represent not more than two or three per cent of the rice growing area. However, it was suggested that those planning to introduce new species of fish into rice growing areas might like to select non-injurious species for introduction and take the necessary steps to prevent the injurious species of fish from being introduced.

The delegate from France recognized that time was not available for a complete review of all of the pests of rice and emphasized the need for a list of all of the species, and for more information on the biology and ecology of different species involved.

India: By far the most serious pests are the stem borers, of which Schoenobius incertulas is the commonest. Other stem borers include Chilo suppressalis, Chilotraea polychrysa, Scirpophaga innotata and Sesamia inferens. Also of considerable importance, and occurring in most rice tracts, is the gall midge Pachydiplosis oryzae, while other common pests are rice bugs Leptocorisa varicornis and L. acuta, and the rice hispa Hispa armigera and Hispa lebongen and Leptispa pygmaea, the leafhoppers and fulgorids, especially Nephotettix apicalis, N. bipunctatus, Nilaparvata sordescens, Nilaparvata lugens the case worm Nymphula depunctalis, and the leafroller Cnaphalocrocis medinalis, the grasshoppers Hieroglyphus banian, H. nigrorepletus, Oxya velox, Colemania sphenarioides, the swarming caterpillar Spodoptera mauritia, the army worm Cirphis unipuncta, the hairy caterpillar Metanastria hyrtaca, the mealy bug Ripersia oryzae, etc.

Iran: Insect pests do not constitute a serious problem, but the wild boar causes considerable damage in rice fields.

Italy: Normally insects cause little damage but crabs cause trouble in some years.

Japan: Stem borers Chilo suppressalis and Schoenobius incertulas are of primary importance but damage is also caused by many other pests, of which the most serious are the white-back, green and brown leafhoppers Sogata furcifera, Nephotettix cincticeps and Nilaparvata lugens, the black bug Scotinophara lurida and the rice bug Leptocorisa varicornis, the rice stem maggot Chlorops oryzae, the rice plant skipper Parnara guttata, the rice leaf miners Agromyza oryzella, and Hydrellia griseola, the rice leaf beetle Lema oryzae, etc.

Pakistan: The stem borer Schoenobius incertulas causes most damage. Other pests which are of importance are the swarming caterpillar Spodoptera mauritia, hispa beetle Hispa armigera, the rice bug Leptocorisa varicornis, the caseworm Nymphula depunctalis, the leafhopper Nephotettix bipunctalis, etc.

Philippines: Although at least 45 species of insects infest rice in the field, the most important are four species of stem borers, of which Chilo suppressalis comprises about 84 per cent. However, Schoenobius incertulas is the most abundant species on certain varieties of rice. Other borers include Scirpophaga innotata and Sesamia inferens. Additional important insect pests include Spodoptera mauritia, Leptocorisa acuta and Cnaphalocrocis medinalis. Also swarms of Locusta migratoria manilensis menace the crop periodically.

Thailand: Three species of stem borers, Schoenobius incertulas, Sesamia inferens, and Chilotraea polychrysa are important, the one most generally distributed and causing the greatest loss being Schoenobius incertulas. Also widespread are army worms, particularly Spodoptera mauritia and Cirphis spp., leaf hoppers including Nephotettix bipunctatis, N. apicalis and Nilaparvata oryzae, and thrips Thrips oryzae. In the south Leptocorisa acuta occurs commonly. Other important pests include the rice skipper Baoris oceia farri, the lesser seedling cutworm Spodoptera pecten, the vegetable cutworm Prodenia litura, the rice case worm Nymphula stagnalis, the grasshopper Oxya velox, the rice hispa Hispa armigera, the stink bug Podops coarctata, the gall midge Pachydiplosis oryzae, mealy bugs, etc. Among non-insect pests, rats, birds and crabs may be very destructive.

United Kingdom: In Hong Kong stem borers are of first importance while leaf rollers also cause damage. In Sierra Leone insect pests cause relatively little trouble, although army worms and the gregarious green grasshopper may occasionally reach serious proportions. Crabs assume pest status in certain riverine areas, while inland the weaver birds and Thrinomus swinderiamus are destructive.

United States of America: Most serious is the rice stink bug which feeds on the developing grain. Other insect pests of varying importance are the water weevil, the grubs of which are found on the roots, and several leaf-eating and stem-boring insects.

Viet Nam: Of greatest importance are the stem borers Schoenobius incertulas, Chilo suppressalis and Sesamia inferens, and the army worm Spodoptera mauritia. Other important insects include the leaf hoppers Nephotettix apicalis and Sogata pallescens, the caseworms Nymphula depunctalis and Nymphula fluctuosalis, the gall midge Pachydiplosis oryzae, the Coreid bugs Leptocorisa acuta and Leptocorisa varicornis, the cutworm Prodenia litura, the leaf roller Cnaphalocrosis medinalis, the grasshopper Oxya velox and other species such as Dasychira pennatula, Melanitis leda, Hispa aenescens, Gryllotalpa spp., Podops coarctata, Nezara viridula, Tetroda histeroides, etc. Of the non-insect pests, birds, rats and crabs are often injurious.

It is noted that stem borers are almost universally present and are the insects of greatest economic importance in most countries. Several other insects, such as army worms and other leaf-feeding insects, the gall midge, thrips, leaf hoppers, grain-sucking bugs, etc., also frequently cause appreciable damage. Of the non-insect pests, the main destructive groups are rats, crabs and birds.

II. Diseases

As in the case of pests, the disease situation in different countries was briefly reviewed and delegates drew attention to the most serious diseases in their territories.

Australia: In Northern Australia where rice growing is still in an experimental stage, several diseases are present but none is of economic importance. Foot rot caused by a species of Fusarium is regarded as being potentially the most dangerous disease present and the possibility of damage in the future from blast (Piricularia oryzae), narrow brown leaf spot (Cercospora oryzae) and brown spot (Helminthosporium oryzae) is recognized. In Southern Australia no diseases have been recognized.

Ceylon: Blast is the most serious disease. Brown spot is also common in all parts of Ceylon but causes severe damage only in certain years. Sheath blight (Hypochnus sasakii) causes heaviest losses in the south-west, where the disease presents a bigger problem than blast. Helminthosporium sigmoideum and H. sigmoideum var. irregulare (stem rot) are of common occurrence and cause damage following floods.

Federation of Malaya: Blast, brown spot and narrow brown leaf spot (Cercospora oryzae) are the commonest diseases and all are widespread in Malaya, but damage in all cases is relatively light.

France: In France the only disease of economic importance is blast. In West Africa two diseases are of importance. These are blast and brown spot, while false smut (Ustilaginodea virens) is common on the Ivory Coast. In Central Africa the commonest diseases are those caused by Piricularia oryzae, Fusarium moniliforme var. oryzae, F. nivale var. oryzae, and Phyllosticta oryzae. In Madagascar Piricularia and Fusarium moniliforme are of greatest importance.

India: The most important disease is blast, which occurs throughout the country but is most severe in the States of Andhra, Bombay, Kashmir, Madras and Mysore. Brown spot is also widespread and is very common in the States of Assam, West Bengal, Bihar, Orissa, Andhra, Kerala and the coastal districts of Mysore. Stem rot, foot rot and root rot complex may also cause severe losses. Other diseases include the narrow brown leaf spot, sheath rot, kernel smut, false smut, udbatta, ufra and bacterial leaf stripe, etc. In all about 38 species of diseases are listed from India.

Iran: Two major diseases occur, of which the more important is brown spot. This disease occurs both on the seedlings and after transplanting. Blast is also present, causing most damage in the rotten neck phase.

Italy: Comparatively little trouble from diseases is encountered. Brusone, caused by Piricularia oryzae and Helminthosporium oryzae, is normally of little importance, although heavy attacks do occur, particularly where high rates of fertilizer application are used. The other main diseases are stem rot (Sclerotium oryzae) and bakanae (Fusarium moniliforme), of which stem rot is the more important.

Japan: Although more than 45 diseases have been recorded from Japan, only a few of these can be regarded as major diseases. Blast is of first importance, followed by brown spot. Other diseases which should be mentioned are bacterial leaf blight (Psuedomonas oryzae), sheath blight (Corticium sasakii), downy mildew (Sclerospora oryzae) and the viroses-dwarf, yellow dwarf, stripe, and black-streaked dwarf.

Pakistan: Brown spot is the most prevalent disease and occurs on both leaves and grains. It is usually of little importance, although very serious epidemics are occasionally encountered. Blast is found both as a leaf spot of seedlings and as a grain disease, but the empty ear type of infection is rare Several other diseases, including foot rot (Gibberella fujikuroi), are present, damage caused by them being comparatively slight.

Thailand: Nineteen diseases have so far been identified in Thailand, but of these only a few are at present known to cause serious damage. The more important diseases include blast, foot rot (Gibberella fujikuroi) which is serious in the north, stem rot (Leptospheria salvinii) and Helminthosporium sigmoideum var. irregulare) and bacterial blight (Pseudomonas oryzae) which is severe in rainy weather.

United Kingdom: In Hong Kong blast is common, severe attacks tending to be restricted to the drier areas. Brown spot also causes some damage. In Sierra Leone blast has been recorded on dryland nurseries but can be regarded as of minor importance and can be controlled by the use of wet nurseries and manuring with superphosphate.

United States of America: In California diseases cause no trouble, probably because the climate is inimical to their development. In Arkansas, Louisiana and Texas several diseases are present, but only blast occurs in epidemic form. Less serious pathogens are Fusarium spp. causing seedling blight, Cercospora oryzae (narrow brown leaf spot), Helminthosporium oryzae (brown spot) and Neovossia horrida (kernel smut). Straight head, a physiological disease which may be induced by excess arsenic in the soil resulting from spraying of previous crops with arsenic insecticides or by excessive amounts of undecomposed organic matter in the soil, is also common, while the virus disease, hoja blanca, threatens certain areas.

Viet Nam: Only blast, sclerotium and helminthosporium diseases cause significant damage. Sclerotium oryzae, Helminthosporium oryzae and Cercospora oryzae are present but are of minor importance.

From the information supplied by delegates, it was apparent that blast is by far the most important disease in most countries. Brown spot is also serious in some areas (e.g. India, Iran, Pakistan). Different aspects of these diseases are dealt with in subsequent sections of this report. While it was recognized that blast and brown spot are of primary importance and should, therefore, be given priority in any program of investigations, it was nevertheless considered that the seriousness, potential or actual, of the large number of other diseases attacking rice should not be ignored.

The Working Party considered the large number and variety of pests and diseases attacking paddy, recognized a need for more information on the species involved and recommended -

> that member governments make a careful survey of all pests and diseases damaging paddy in the field, provide FAO with lists of these pests and diseases, indicating the degree of economic importance (major or minor) of each organism, and notify FAO of the finding of new species of paddy pests and diseases;
>
> that as an aid to this project FAO prepare a list of the species and their distribution on the basis of literature and reports received, circulate it to member countries for corrections, additions and an indication of the respective importance of the species in the different countries, and maintain a cumulative index indicating the distribution and relative importance of the different paddy pests and diseases.

Assessment of Field Losses Caused by Pests and Diseases

I. Pests

Methods of assessment of crop losses due to various pests were reviewed by delegates.

In Ceylon attempts have recently been made to evolve a technique for the evaluation of losses caused by various insects by means of simple field trials. Losses were estimated by comparing the yield of grain obtained from plots protected from insect attack by frequent treatment with insecticides with the

yield from unprotected plots. Despite the limitations of this method, such as the incomplete control of insects achieved in the sprayed plots and the possibility of a direct effect on yield from the insecticide itself, it does give some estimate of losses incurred.

In the French territory of Chad estimates of the damage done by one pest (the stem borer Proceras africana) have been made by determining the number of plants attacked and the amount of damage caused. From the data so obtained the percentage damage was assessed.

In India investigations to discover suitable methods for assessing losses due to various pests have been carried out. For stem borers the methods used have been based on counting the number of white earheads present in observation plots, or have depended on controlling infestation by spraying with insecticides at various growth phases of the rice plant. Gall fly damage was also estimated by experiments in which the insect was controlled by various times and methods of application of an organophosphorus insecticide. In the case of Hispa, assessment of damage was worked out on the percentage of affected leaf area, but loss of yield was not calculated.

In Japan techniques for the assessment of damage to the rice crops by the various pests have been developed. The techniques involve the use of treated and untreated plots. Results of these studies were presented to the 1954 IRC Working Party Meetings in Tokyo.

The Working Party considered the need for additional accurate information on the magnitude of losses caused by pests in the majority of member countries, recognized the value of this information to member governments for purposes of deciding upon the size of their individual efforts required to reduce or eliminate these losses and recommended -

> that member governments should take immediate steps to secure information on the overall losses caused by insect pests and, whenever possible, the losses caused by individual paddy pests.

Suggested method for assessing pest losses. The Working Party considered various ways and means of securing this information and the difficulties involved in obtaining accurate data on this subject and the fact that member countries have various laws regulating the use of certain pesticides. It suggested that workers follow the method of treated and untreated plots of randomized distribution to make these assessments, and the following procedures were suggested:-

(1) In general, and within practical limits, the larger the plot size the more accurate the assessment of pest damage should be, provided care be taken to ensure that the experimental areas are uniform in regard to variety, fertility, stand, and other growth factors. Uneven growth areas, such as the edges of an experimental field, should not be included in test plots.

(2) At each location there should be at least four replications each consisting of a sprayed and an unsprayed plot, covering an overall area of an acre or more (i.e. 1/8 acre per plot).

(3) Where plot size is smaller, the number of replications or locations for these tests should be increased.

(4) The insecticide or combination of insecticides to be used in the routine treatments of the plots as may be required to secure effective control of the insect pests that may be present, is to be left to the discretion of the specialists in each member country.

(5) Insecticide applications should be made at intervals of not less than two weeks, or as may be required to ensure the most effective control of pests from the seedling to the harvest stage of the crop.

(6) Assessment of pest damage should be based on an analysis of the difference in yield between the treated and untreated plots. Moreover the member countries are urged to secure as much information as possible on the relative abundance and importance of the various species of insects that may be present in the experimental pest assessment plots.

(7) Where more than one crop is grown per year, tests should be conducted during each cropping season.

(8) Each country should decide on the number and location of its respective test sites.

(9) The yearly results of the experiments should be forwarded to Dr. H.G. Walker, FAO, Rome, Italy, for preparation of an overall report, summarizing the results obtained for circulation to member countries cooperating in the tests.

(10) It was further recommended that FAO should give consideration to the possibility of the formation of a technical study group to review the results obtained in these preliminary tests in 1960 and prepare recommendations for 1961, etc.

II. Diseases

Comparatively little information was available to delegates on the subject of methods for assessing field losses due to diseases, although a valuable summary of methods used in India with respect to blast was presented.

The Working Party recognized that the accumulation and compilation of exact information on the subject was highly desirable so that the economics of control measures could be accurately worked out and the relative importance of the different diseases more precisely evaluated. It agreed, however, that in view of the present lack of information on methods for carrying out such studies, it was not desirable immediately to attempt to formulate standardized experimental techniques for use by participating countries in a cooperative project. It was considered that action in the first place should be confined to the collection of all available data on the subject.

The Working Party recommended that attention should for the present be concentrated on blast, this being by far the most serious disease in the majority of the territories. It also recommended that as a preliminary to the formulation of methods of assessment suitable for use by all countries interested in the subject, FAO should collect and collate all available information either from the literature or by consulting experts on the subject and thereafter circulate the relevant information to member countries.

Methods of Forecasting Outbreaks of Pests and Diseases.

I. Pests

Methods of predicting outbreaks of insect pests, particularly stem borers, in use in various countries were briefly reviewed. The use of light traps to obtain information on the time of peak emergence of borer moths is the commonest method being employed in Japan, India and Viet Nam. The method has also been under investigation recently in Ceylon. A more recent method being employed in Japan is the incubation method in which the time of pupation under controlled conditions is used to forecast the time of moth appearance.

In considering the possibility of conducting more widespread investigation of this problem, the Working Party recognized that member countries varied greatly in the availability of technically trained personnel for entomological studies and that wide variations existed in the availability of detailed knowledge of the biology and ecology of pests of paddy in member countries, realized the pressing need for this information in order to be able to forecast pest outbreaks to secure the most economical and effective control, and recommended that in so far as possible member countries -

> Use the method of direct and careful field observations and known ecological and biological factors to achieve the earliest possible recognition of the onset of a pest attack and issue timely warning by the most effective local methods so that cultivators may carry out properly timed, recommended control measures;
>
> Conduct more detailed biological and ecological studies on the major insect pests of paddy in order to be able to provide the basic information needed to evolve effective forecasting techniques for each pest concerned.

II. Diseases

Methods of forecasting outbreaks of blast disease used in India, Japan and Ceylon were reviewed.

In India preliminary work on this subject has recently been started at the Central Rice Research Institute, Cuttack. The method used is the study of the pattern of outbreaks and the development of the disease on plots of a susceptible rice variety planted at four different dates. In addition spore trap records are kept and observations made on various environmental factors.

In Japan forecasting of blast outbreaks has been carried out for some time. A method in common use is the observation of the development of the disease on

susceptible seedlings. Normal outbreaks of the disease, which are repeated each year at approximately the same time, are forecast by correlating information on weather and other environmental conditions, the seedling method being used only for predicting severe outbreaks which occur unexpectedly.

In Ceylon an attempt has recently been made to develop a means of forecasting blast attacks suitable for the local conditions. The seedling infection method used in Japan is applicable only where planting time and various cultural practices are uniform over a large area. In Ceylon this does not occur and the method cannot be applied.

The importance of this line of investigation was recognized by the Working Party and it was agreed that member countries should pay attention to it, confining activities in the first instance to blast, this being the disease of most importance and also the one on the prediction of which most information is available. It considered that insufficient information was available for detailing immediately a satisfactory method of forecasting for use by member countries in a cooperative project. It therefore recommended -

> that as a first step towards developing such a method, all available information should be collected, summarized and circulated to member countries by FAO, with a view to these countries carrying out preliminary trials on the subject;
>
> that countries carrying out such work should report on their progress to the next meeting of the Working Party.

Methods of Controlling Pests and Diseases

Pests

1. Cultural and mechanical control: The Working Party recognized the great importance of cultural and mechanical methods of pest control, such as the prompt destruction of crop residues containing pests, variations in planting dates to avoid peaks of emergence of pests, etc., but decided that time was too short to discuss these relatively well known important methods of control.

2. Biological control: Dr. V.P. Rao, Entomologist in charge of the Commonwealth Institute of Biological Control, Indian Station, summarized the salient parts of his paper "Natural Enemies of Rice Stem Borers and Allied Species in Various Parts of the World and Possibilities of their Use in Biological Control of Rice Stem Borers in Asia". He said that the possibilities of using this method successfully were great if a large exchange of insect parasites, predators, nematodes and mites as well as insect pathogens attacking stem borers could be undertaken between countries under the aegis of FAO, or by direct agreement, care being taken to avoid the introduction of secondary parasites or other injurious species.

Such an exchange undertaken at the same time would not only facilitate work but also make the project less expensive than when conducted by individual countries at different times. Dr. Rao gave examples of some of the important

known egg, larval and pupal parasites of stem borers in the old and New World, which could be exchanged. He, however, suggested that more detailed surveys be made in each country so that exact information regarding availability and distribution of natural enemies could be obtained and their correct determination made. He said his Institute could give any assistance needed in the matter of identification of specimens and that he would be especially glad to receive specimens of parasites, predators and pathogens for study and inclusion in the collection of the Institute. He further explained certain difficulties encountered in obtaining quick air transportation of beneficial insects and suggested that FAO investigate what could be done to overcome them in order to facilitate their quick and safe exchange.

The delegates from Ceylon and Thailand also urged that more attention be paid to the biological control method. The latter said that the use of bacterial and virus diseases might be very useful and should be given careful consideration and study.

There was some discussion as regards the trial of chemical and biological control methods at the same time and in the same locality. In view of their possible incompatability, it was suggested that the trial of the biological control method should be carried out in areas where chemical control was not in use.

The Working Party placed on record its appreciation and sincere thanks to the Director, Commonwealth Institute of Biological Control, Ottawa, Canada, for sending its delegate, Dr. V.P. Rao, to attend these meetings and was grateful to him for agreeing to collaborate with FAO in initiating a program for the exchange of natural enemies of rice stem borers, subject to an agreement in regard to the provision of funds for this work by the member countries concerned.

After the Working Party had briefly reviewed the present status of the biological control of stem borers and other paddy pests, it recommended -

> that member countries, in so far as available personnel will permit, make detailed surveys and collect information and specimens of various natural enemies, including pathogens of rice stem borers and other insect pests of paddy, and have them identified;
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> that member countries review the lists of parasites and predators compiled by FAO and send suggestions, corrections, additions, including lists of pathogens to Dr. Harry G. Walker, FAO, Rome, Italy, for use in the preparation of a revised and more complete list.
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> that when requested FAO assist member countries in making arrangements for the exchange of parasites, predators and pathogens under the supervision of the Commonwealth Institute of Biological Control or other responsible organizations working in this field;
>
> that FAO investigate the possibility of securing quick transportation of consignments of beneficial insects by air in passenger cabins, not in cold freight compartments, categorizing these beneficial insects under a separate category and not as "livestock". It was

further requested that in view of the great importance of these exchanges to the world food supply, consideration be given to the transportation of these specimens at reduced rates by the airlines. Also, in carrying these consignments in passenger cabins, the danger of their being sprayed by health and plant quarantine authorities in certain airports should be considered, and ways and means found to safeguard these beneficial insect consignments;

that where necessary, all governments be requested to amend their plant quarantine, as well as import or export regulations, in order to expedite the transfer of beneficial specimens as rapidly as possible, and issue necessary instructions to their respective customs and commerce authorities in order to avoid delays in shipment and the loss of valuable living specimens.

3. Chemical control: The Working Party recognized that many countries were obtaining outstanding benefits from the use of pesticides, often resulting in increased yields ranging from 15 to 50 percent, or even more, depending upon the severity of the infestation. However, because of a shortage of time, the delegates confined their remarks to statements regarding control measures being taken in their respective countries on some of the most important pests.

In Australia good control of Chironomids is achieved with dieldrin, applied as a drip feed in the inlet water in irrigated areas. These pests can also be treated successfully with dieldrin or DDT, applied as a spray before germination of the rice. Caddis flies are controlled at the same time by these treatments.

In Ceylon several experiments have recently been carried out on the control of stem borers with the object of finding the most effective insecticide. W L1650 has given the best results, while endrin was nearly as effective. Parathion was less effective than endrin, and dipterex has not given good control.

In French Territories in Africa DDT, BHC, parathion, toxaphene and other insecticides are used against various insects with good effect.

In India stem borer control is under investigation, using BHC, DDT, folidol, parathion and endrin. Their use has resulted in increased yields of over 50 percent. Against gall fly, dusting with BHC, and spraying with folidol, parathion or endrin have been found effective.

In Italy insects are of little importance on rice in the field and control measures are not generally practised.

In Japan many insecticides are recommended for the control of stem borers, including parathion, EPN, diazinon and dipterex. Endrin has also proved effective but its use in rice fields is now prohibited because of its high toxicity to fish. Other insects controlled by chemical means include leaf hoppers with BHC, DDT and malathion, the black rice bug with parathion and BHC, and the rice bug with BHC, parathion and DDT.

In Pakistan endrin has been used extensively for controlling insect pests of rice, application being made both from the ground and from the air. However,

because of its high toxicity to fish and poultry, its use is now being restricted, and other insecticides are being employed in its place, especially around waterways and ponds where fish are breeding.

In the Philippines the use of pesticides has given very promising results. In preliminary comparative tests at a dosage of one quart per 100 gallons of water, endrin gave 75 per cent control of stem borers as compared with 50 per cent control by EPN. Neither material gave promising results at lower dosages.

In Taiwan large quantities of parathion, PM (a mixture of parathion and malathion), diazinon, and endrin have been used for control of stem borers with excellent results (e.g. increased yields ranging from several hundred to 2,000 kilograms of paddy per hectare). In comparative tests dipterex has not given as promising results as parathion in Taiwan. BHC is used extensively for the control of paddy pests other than stem borers, from 77,000 to 80,000 hectares being treated annually in recent years.

In Thailand the main problem in the control of pests with chemicals is one of application rather than of insecticides, obstacles to efficiency arising from the nature of the terrain and the lack of equipment suitable for local conditions. Ground spraying equipment at present available is difficult to use in the rice fields, and aerial spraying is not altogether satisfactory because large uninterrupted areas of rice without habitations, etc., are rare.

United Kingdom: In Hong Kong endrin is used extensively in control of borers and leaf hoppers. There are strict regulations regarding the use of insecticides because of the danger of toxic residues finding their way on to vegetable crops. Aerial spraying is at present under test.

In Viet Nam stem borers are controlled by spraying with endrin, malathion or parathion. DDT, dieldrin and BHC are effective against army worms and Nymphula.

Having reviewed the latest developments in the use of pesticides for control of paddy pests, the Working Party recognized the necessity for, and outstanding benefits of, increased yield and better quality harvests to be derived from the use of pesticides, considered the need for adequate precautions to be taken to protect the user from the hazards of highly toxic pesticides and the consumer from toxic pesticide residues that might remain on or in treated crops and recommended -

> that member governments keep FAO regularly informed of effective new or improved pesticide techniques for control of various paddy pests, and FAO circulate this information to member countries through the IRC Newsletter, the FAO Plant Protection Bulletin or by direct correspondence, as may be most appropriate;
>
> that member governments consider enacting regulations to control the importation, manufacture, formulation, packaging, labelling, and distribution of chemicals within their territories;
>
> that member governments consider ways and means of developing effective methods for control of pesticide residues to protect consumers of treated crops from possible hazardous residues;

that FAO consider the possibility of obtaining and disseminating recent and new information that has or may be developed from time to time on the safe use of new or recommended pesticides;

that FAO consider the possibility of organizing a Technical Study Group to review the latest developments in the control of stem borers, gall midge and other important insects, especially those that feed within the stems of paddy plants, in order to develop a well coordinated program for the study of the biology, ecology and control of those pests which are considered to be the most important paddy pests and to be presenting the greatest need for international cooperation to determine the safest and most effective measures for reducing the losses caused by them.

4. Insect control by varietal resistance: The Working Party considered the available information on paddy varieties resistant to insect attack and noted that apparent differences do exist in the susceptibility of varieties to attack by some species of insects, especially dipterous pests. It noted that results to date indicated that breeding for resistance to insect attack did not appear to be nearly as promising or desirable as breeding for resistance to blast and other diseases, but recommended that entomologists be encouraged to examine rice variety and breeding trials in order to secure information on possible resistance or variations in the susceptibility of the varieties to insect damage.

I. Disease

1. Control by fungicide: In the discussion of this topic most attention was paid to chemical and cultural methods of control, and delegates reported on practices encountered in their territory.

Australia: Diseases do not cause economic losses at present and no control measures are practised.

Ceylon: Seed disinfection is used to control foot rot and is very effective. It is also recommended as a general treatment for all rice seed, as it has been demonstrated that brown spot attack on seedlings may be reduced in this way, and it is possible that blast may also be controlled to some extent.

Field spraying against blast is under active investigation. Mercurial compounds have not been found suitable for use with indica varieties due to phytotoxicity, but antibiotics are giving substantial promise.

Federation of Malaya: Although many diseases are present serious losses are not encountered and control measures have not been practised to any extent.

France: In France chemical control measures have recently been put into practice against blast. These include seed treatment and spraying of seedbeds with mercurial fungicides. Cultural methods advocated include burning and ploughing of the stubble and the avoidance of uneven distribution of nitrogenous fertilizers. Resistant varieties are also available.

In African territories little in the way of chemical control is done because of economic factors. Treatment of seed, however, is carried out, formalin treatment being recommended because of the dangers attendant on treating with mercurial compounds.

India: Chemicals are used as seed disinfectants for the control of foot rot and brown spot. Spraying and dusting of the growing crop against blast and brown spot with copper and mercurial fungicides has also been investigated but additional information is needed before effective spraying and/or dusting schedules can be recommended. Cultural methods employed include the destruction of stubble, eradication of grasses which act as alternate hosts, adjustment of time of planting, the judicious use of fertilizers and control of irrigation water.

Iran: A trial of seed treatment with Ceresan, both as a solution and in powder form, gave no results. There was no difference in growth between plants from treated and untreated seed.

Italy: Although brusone at one time caused trouble, little damage has been encountered since the introduction of resistant varieties from Japan. Occasional outbreaks occur but these can be prevented by avoiding the use of excessively heavy applications of nitrogenous manures. Seed treatment has been tried but has not been found advantageous.

Japan: The latest experiments on blast control have been in connection with the use of antibiotics, but these have been found toxic to japonica varieties and no conclusions can yet be drawn from the tests. Mercurial fungicides are widely used for seed treatment and for control of blast in the field.

Pakistan: Diseases are of comparatively slight economic importance and little is done as regards control. Brown spot in some years causes severe losses, and as a precaution seed dressings are applied.

Philippines: Little is done in the way of control of diseases as they normally do not cause much trouble. In one area losses due to root rot have been severe but resistant varieties are now being planted and good control has been achieved in this way.

Thailand: Control measures have not been practised to any great extent but investigations on the subject are being intensified. Mercurial fungicides are under test for the control of the neck rot phase of blast but the toxic effects of these chemicals on the local varieties reduce their usefulness.

United Kingdom: In Hong Kong blast is of some importance, but its severity has been reduced by the use of resistant varieties. Mercurial fungicides are used and dusting with Ceresan has recently been found effective. Seed treatment has been found to improve germination and its use is being introduced.

United States of America: The only control measure recommended is seed treatment with Arasan and Ceresan against seedling blight. Very little seed is treated in this way and benefit is found mainly under low temperature conditions. Against blast mercurial dusting has been tested but use of such dusts is not now allowed because of possible toxicity hazards.

Viet Nam: Chemical control measures employed include seed disinfection with formalin and spraying with Bordeaux mixture against blast. The main measures used against various diseases and cultural measures include burning of the crop residues after harvest, destruction of alternate hosts, control of irrigation water, adjustment of planting times, careful application of fertilizers and the avoidance of dense planting. Varieties resistant to sclerotium disease are available.

Although not specifically included in this discussion, most countries have blast resistant varieties and have active breeding and testing programs, as discussed later, for the development of new and improved varieties.

In reviewing the different fungicides used for controlling blast, it was noted that both copper and mercury compounds are used for blast control in some areas. However, the copper compounds are not too effective, especially during severe outbreaks, and the mercury compounds have caused injury to the indica varieties of rice in Taiwan, Thailand and Ceylon and may leave hazardous residues on the treated crop. Although the antibiotics have shown promise, they have caused some injury to seedlings. The Working Party noting the need for improved chemical control measures for such diseases as blast, recommended that member countries keep FAO informed of new developments in fungicide control and that FAO circulate this information to member countries.

2. Control by breeding and testing for resistance to blast and other diseases:

Due to increasingly serious losses caused by blast (Piricularia oryzae), the Sixth Meeting of the Working Party on Rice Breeding, 1955, recommended that "member countries should, wherever facilities exist, intensify their work on breeding new varieties resistant to the blast disease. Genetic stocks maintained at the four centres, with the exception of Indonesia where blast disease does not occur, should be tested for susceptibility to blast in order to isolate resistant varieties. The Director, Central Rice Research Institute, Cuttack, should prepare for distribution a list of resistant varieties available; in view of the possible physiologic specialization of the pathogen, all resistant varieties, wherever growing, should be tested in all countries where blast occurs and full information of the conditions under which they are grown in the country of origin should be furnished".

In pursuance of the above recommendation, information was collected regarding the availability of rice varieties resistant to blast from Burma, Ceylon, Egypt, India, Indonesia, Japan, Malaya, Pakistan, the Philippines, Taiwan, Thailand, and the U.S.A. Arrangements were also made for the distribution of the seeds of resistant varieties to testing centres in Egypt, India, Japan, the Philippines, Taiwan, Thailand and the U.S.A.

The results from India, Japan, the U.S.A. and the Philippines for the period 1956-58 were summarized and presented to the Working Party. Forty-three varieties have been tested in two or more countries. None of these varieties has been classified as resistant in all countries. Thirteen of the varieties have been classified as resistant in one and four varieties in two countries. Ten varieties from Burma which have been tested only in India have all been classified as susceptible. Several other countries reported on inconsistent results with regard to resistance. It has also been found that varieties

which are regarded as resistant in their country of origin are often badly attacked by blast when introduced into other countries. In some cases the opposite has been recorded. This inconsistency is due either to the occurrence of different biotypes of the fungus or to the influence of environmental conditions. It was reported that in Japan 15 different races of blast have now been identified. These 15 races are classified into three main groups after their infection pattern. New varieties which are highly resistant to blast in the country of origin have been developed in several countries.

As blast is becoming more and more important with the increasing use of nitrogen and more intensified cultural practices, it was felt that the breeding for resistance to blast should be intensified in all countries. In order to find reliable resistant parent material it was suggested that uniform blast nurseries should be established, and a Committee consisting of Dr. L.H. Fernando, Botanist and Senior Agricultural Research Officer, Peradeniya, Ceylon, Chairman, Dr. H. Okamoto, Chugohu Agricultural Experiment Station, Himeji, Hyogo, Japan, and Dr. S.Y. Padmanabhan, Central Rice Research Institute, Cuttack, Orissa, India, was appointed to work out plans and instructions for such nurseries. FAO was requested to collect varieties with the highest possible resistance to blast from the genetic stocks and from other sources for inclusion in the nurseries. It was also suggested that all new information on resistance to blast and other diseases be sent to FAO to be listed and published as an appendix to the genetic stocks catalogue.

Attention was also drawn to damage caused by other diseases and to the need of varieties resistant to them. As, however, none of these equal blast in importance, it was agreed that each country should continue or take up work on those diseases of more importance to it, but that the cooperative work in the Working Party for the time being should be concentrated on blast.

The Working Party, recognizing the great amount of damage caused by blast and the need for a more thorough knowledge of the fungus and the importance of the development of resistant varieties recommended -

> that uniform blast nurseries be established in as many of the participating countries as possible, and appointed a committee consisting of L.H. Fernando, H. Okamoto, and S.Y. Padmanabhan to work out detailed plans and instructions for these nurseries;
>
> that FAO collect seed of the selected blast resistant varieties from the countries of origin for distribution to the countries conducting the nursery trials;
>
> that member countries send FAO any new information as soon as it may be obtained concerning varietal resistance to blast and other diseases for publication in an appendix to the Genetic Stocks Catalogue;
>
> that further work on blast race identification be conducted in all countries wherever facilities for such work exist and the results obtained be reported to the next meeting of the Working Party;

that work on breeding for resistance to other diseases and pests be continued and strengthened in those countries where resistant varieties are needed, and results from that work be reported to the next meeting.

III. Nematodes

Due to a shortage of time the Working Party was able only to review very briefly this important problem.

Pakistan reported that Ditylenchus sp. became a very serious problem in deep water paddy in East Pakistan about 1913 and continued to cause serious losses until it was learned that burning the straw on infected fields would give effective control. Then during the War fuel became very scarce and the cultivators began collecting the straw for fuel; as a result the nematodes are again becoming a serious problem.

Ceylon reported that white tip (Aphelenchoides oryzae Yahoo) had been noted in Ceylon for the first time about three months ago and the authorities were concerned about it.

Taiwan reported that white tip was present in that country.

U.S.A. reported that white tip had been present there for a number of years and stated that hot water treatment of infected seed would give effective control which would last for several years. However, it was reported that resistant varieties had been developed which had greatly reduced the importance of this pest.

The Working Party recognized the growing importance of nematode problems in many crops, other than rice, noted the scarcity of information on the nematodes attacking rice and recommended that FAO investigate the possibility of developing a cooperative program for making a survey of such nematodes. If plans for such a program could be developed, member governments should cooperate with the collection of samples for examination and study in accordance with the plans that may be developed for the survey, the results obtained to be reported to the next meeting of the Working Party.

IV. Weeds

The Working Party expressed much interest in the many problems of weed control in the short time available for discussion on this important problem. The brief discussions indicated that graminaceous weeds, especially Echinochloa spp. and Panicum spp., are the most important weed pests of paddy. However, Chara spp. and many other species of weeds may be important pests in certain areas. Weed control problems are much more serious and difficult to control in broadcast than in transplanted paddy.

U.S.A. reported that a method of controlling weed grasses in the south-eastern rice producing area, involving the use of CIPC in combination with several cultural management practices, including the planting of the paddy from one to two inches deep to avoid injury to the roots, has been developed. The combination herbicide-cultural practice was used effectively to control barnyard grass and other weed grasses in more than 5,000 acres of commercially grown rice in 1959.

In the Western rice producing area, CIPC and EPTC in combination with various cultural practices have shown experimental promise for the control of barnyard grass and other weed grasses, but these herbicides are not presently suggested for commercial use.

Intensive fundamental investigations have been conducted to develop basic information on the use of 2, 4 - D, MCPA, 2, 4, 5 - T and Silvex for the most effective control of a wide range of broadleaved weeds and sedges with minimum risk of injury to rice. It is estimated that over 40 per cent of the total rice crop in the United States is treated annually with phenoxy-acetic acid type herbicides for control of weeds.

Basic and applied studies are being continued to improve current control practices and to develop new herbicides and new and improved chemical-cultural methods of controlling weeds in paddy.

India reported that much work is in progress with 2, 4 - D, MCPA and 2, 4, 5 - T for control of weeds in paddy fields. Most promising results have been obtained with MCPA at dosages of two pounds of acid equivalent applied about four weeks after transplanting. Pre-emergence weed control tests have not given promising results to date. The cost of the use of chemical herbicides has compared favourably with hand weeding. Herbicides have not given good results in broadcast rice. Panicum spp. are the most important paddy weeds.

Australia reported that CIPC has not given satisfactory results in their tests but that TCA has shown promise. Sod seeding has given indications of being a useful method and may become widely adopted. Aerial seeding of paddy has not been successful because of frequent high winds during planting time.

France reported that numerous surveys have been made on weed control in tropical Africa and Madagascar. Two papers on this subject published by Richard-Toll Experimental Station (Senegal) have stressed the results obtained by means of this control. Panicum spp. are the most important paddy weeds in France. Copper sulphate is used for the control of algae.

Philippines reported that four cultivations during the growth period had given most promising results with some weed species. They have a broad leaved weed, the leaves of which are readily killed by 2, 4 - D but which soon sprout up again from the rhizomes.

Italy reported that weeds are becoming increasingly serious. Weeding costs run as high as 40 - 45 per cent of the cost of rice production. Herbicides eliminated the Cyperaceae but have favoured the development of grassy weeds. They have largely discontinued the use of herbicides because of the danger of injury to the paddy plants.

The Working Party recognized the serious losses caused by weeds and the need for further work on the relative merits of different methods of weed control, including all factors such as cropping procedures, the availability and cost of labour, the use of machinery, chemical weed killers, etc. and recommended that member countries should thoroughly study all phases of this complex problem and be prepared to report on the results obtained at the next meeting of the Working Party.

V. Miscellaneous Pests

The Working Party regretted that time was not available for a discussion of other important paddy pests such as birds, crabs, fish, rodents, and other miscellaneous pests, and recommended that member countries make a study of the various species involved and prepare a report on the status and control of these pests for presentation at the next meeting of the Working Party.

The Working Party noted that Japanese scientists have made many valuable contributions to the knowledge of insects, diseases, weeds and other pests of paddy, much of which is published in the Japanese language and not available in abstracting journals, and recommended that FAO investigate the possibilities of having these articles translated into English and French either in full or in abstract form and circulated to members of the International Rice Commission and its Working Party on Rice Production and Protection.

TIME AND PLACE OF NEXT MEETING

The Working Party noted with satisfaction the suggestion made at the Tenth Session of the International Rice Commission that the next Working Party meeting should be held during 1961. The location is to be determined later.

SUMMARY OF RECOMMENDATIONS

The recommendations made by the Working Party and included in full in the body of the report can be summarized as follows:-

1. That further selections in the japonica-indica hybrid material now available be made on a high fertility level, new hybrids be produced in all countries between the most suitable indica and japonica varieties, all generations be grown under a high fertility level, and the selection be made in accordance with the recommendations given in the report. (Page 9)

2. That in all countries rice geneticists in their future publications use the gene symbols recommended by the IRC and new gene symbols in conformity with the rules adopted by the Tenth International Genetics Congress be set up as the need arises. (Pages 10 and 11)

3. That the investigations on variety-fertilizer interaction be continued and in conducting these experiments, emphasis be laid on establishing reponse curves for the varieties, and in the future breeding work attention be paid to breeding for high fertilizer response together with resistance to lodging and disease. (Page 14)

4. That the investigations on physiological diseases of rice be strengthened in all countries where such diseases occur. (Page 16)

5. That extensive regional testing of varieties be conducted as the basis for the evaluation of already existing varieties and of new varieties and lists of recommended varieties be issued and revised from time to time. (Page 17)

6. That in the breeding programs greater emphasis be placed on selection for varieties with the widest possible adaptability and greater attention be given to fundamental studies on photoperiodism and thermo-sensitivity of rice in order to provide the breeders with basic information relating to the adaptability of varieties. (Page 18)

7. That in connection with the World Seed Campaign steps be taken in all countries to strengthen the work on rice seed improvement, special emphasis being given to extensive variety tests, reduction in the number of varieties, and production and distribution of seed of improved rice varieties. (Page 18)

8. That a careful survey and identification of all insects and diseases attacking paddy in the field be made by member countries and FAO provided with a complete list of the species found. (Page 23)

9. That immediate steps be taken by member countries to secure information on the overall losses caused by insects and, whenever possible the losses caused by individual pests, the results to be forwarded to FAO. (Page 24)

10. That in assessing losses caused by diseases, major attention be concentrated by member countries on evaluating losses caused by blast. (Page 26)

11. That detailed biological and ecological studies on the major insects and diseases of paddy be conducted by member countries, timely warnings be issued to growers of impending outbreaks by the most effective local methods, FAO supplied with available information on forecasting, and a progress report prepared on the results of recent and new work on forecasting for presentation at the next Meeting of the Working Party. (Pages 26 and 27)

12. That the work of member countries on biological control be strengthened by making detailed surveys and collecting information on, and specimens of, various natural enemies including pathogens of rice stem borers and other insect pests of paddy; and reviewing the preliminary list of parasites prepared by FAO, and sending suggestions, corrections and additions, including lists of pathogens, to FAO; and where necessary their plant quarantine as well as import or export regulations be amended in order to expedite the safe transfer of beneficial insects from one country to another. (Pages 28 and 29)

13. That FAO be kept informed by member countries of the development of effective new or improved pesticide techniques. (Page 30)

14. That where needed the enactment of regulations to control the importation, manufacture, formulation, packaging, labelling and distribution of pesticide chemicals within their territories be considered by member countries, and ways and means of developing effective methods for control of pesticide residues to protect consumers of treated crops from possible hazardous residues. (Page 30)

15. That entomologists be encouraged by member countries to examine rice variety and breeding trials in order to secure information on possible resistance or variations in the susceptibility of the varieties to insect damage. (Page 31)

16. That FAO be kept advised by member countries of the development of new or improved methods for the control of rice diseases by fungicides. (Page 33)

17. That in connection with breeding for resistance to diseases uniform blast nurseries be established in as many countries as possible, further work on blast race identification be strengthened in all countries with facilities for such work, work on breeding for resistance to other diseases and pests be continued and strengthened in those countries where resistant varieties are needed, all results in this field to be reported to the next meeting and new information concerning resistance to blast and other diseases of the different varieties be sent to FAO whenever such information is obtained. (Pages 34 and 35)

18. That if satisfactory arrangements be made, member countries to cooperate in a survey of the nematodes attacking rice. (Page 35)

19. That a study of all phases of weed control be made by member countries, which should be prepared to report on the results obtained at the next meeting of the Working Party. (Page 36)

20. That a study be made by member countries of the various species of such pests of rice as birds, crabs, fish, wild hogs, rodents, etc., and a report prepared on the status and control of these pests for presentation at the next meeting of the Working Party. (Page 37)

The Working Party further recommended that FAO should be requested:

1. To collect information on the japonica varieties most suitable for hybridization with indica varieties and to assist in obtaining seed of these varieties. (Page 9)

2. To publish the list of IRC recommended gene symbols in the IRC News Letter, to arrange for the tabulation of characters and the maps of linkage groups prepared by the Committee on Linkage Studies and Nomenclature to be published as soon as possible and to envisage the possibility of publishing a complete set of morphological and histological diagrams of rice. (Pages 10 and 11)

3. To formulate a detailed plan for a project aiming at testing promising varieties, which have shown wide adaptability in their country of origin, for their suitability in other parts of the region. (Page 13)

4. To prepare a preliminary list of the species of the insects, diseases and other pests of rice, showing their distribution and circulate it to member countries for suggestions, corrections, additions and an indication of their importance in the different countries. (Page 23)

5. To prepare an overall report of the results obtained in the cooperative insect control tests and circulate the results to cooperating countries and to consider the possibility of forming a technical Study Group to review the results obtained in 1960 and prepare recommendations for 1961, etc. (Page 25)

6. To assist member countries in making arrangements for the exchange or transfer of parasites, predators, and pathogens of rice field pests, and continue to build up and maintain a list giving the species and the distribution of the parasites, predators and pathogens of rice stem borers and other rice insect pests. (Page 28)

7. To investigate the possibility of securing safe, and cheaper transportation of parasites and other beneficial insects in heated and not in cold compartments of aeroplanes under a special category, and not as livestock. (Page 28)

8. To consider the possibility of obtaining and circulating recent and/or new information on the safe use of new or recommended pesticides, and of organizing a Technical Study Group to review the latest developments in the control of stem borers, gall midges and other important insects, especially those that feed within the stems of paddy plants, in order to develop a well coordinated program for the study of these pests to determine the safest and most effective measures for reducing the losses caused by them. (Page 31)

9. To publish as an appendix to the Genetic Stocks Catalogue new information obtained from various countries concerning resistance to blast and other diseases and pests of various rice varieties. (Page 34)

10. To collect seed of selected blast resistant varieties from countries of their origin for inclusion in the uniform blast nurseries. (Page 34)

11. To investigate the possibilities of developing and organizing a cooperative program for making a survey of the nematode pests of rice. (Page 35)

12. To investigate the possibility of having Japanese publications on problems relating to protection of rice translated into English and French and circulated to members of the IRC and its Working Party on Rice Production and Protection. (Page 37)

PAPERS PRESENTED TO THE MEETING

Australia

Notes on Rice Variety x Fertilizer Interaction Studies in Northern Australia. E.C.B. Langfield and A.L. Chapman, C.S.I.R.O., Division of Land Research and Regional Survey, Kimberley Research Station, Wyndham

Notes on Selection of Indica-Japonica Hybrids at Kimberley Research Station in Northern Australia. E.C.B. Langfield, C.S.I.R.O., Division of Land Research and Regional Survey, Kimberley Research Station, Wyndham

List of Rice Pests and Diseases in Australia. J.J. Basinski and D.M. Doutch, C.S.I.R.O., Division of Land Research and Regional Survey, Canberra

Ceylon

Seed Testing Procedure. Department of Agriculture, Peradeniya

World Seed Campaign in Relation to Rice. A.S. Ranatunga, Secretary, National Seed Campaign Committee, Department of Agriculture, Peradeniya

Seed Rice Programmes in Ceylon. A.S. Ranatunga, Department of Agriculture, Peradeniya

The Progressive Reduction in the Number of Rice Varieties under Issue in Ceylon. L.H. Fernando, Botanist and Senior Agricultural Research Officer, Department of Agriculture, Peradeniya

Summary of Recent Investigations of Variety-Fertilizer Interactions in Rice. M.F. Chandraratna, Director, Department of Agriculture, Peradeniya

The Nature of Fertilizer Response in Japonica and Indica Rice Varieties. Noburn Yamada, Chief Research Coordinator, Department of Agriculture, Peradeniya

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